INSTRUCTION MANUAL

Type 1560-P40 Preamplifier

GENERAL RADIO COMPANY

C

CONTENTS

Type 1560-P40 Preamplifier

C

Handbook of Noise Measurement

This 280-page book, by Dr. A. P. G. Peterson and Ervin E. Gross Jr., of the General Radio Engineering Staff, covers thoroughly the subject of noise and vibration measurement. Copies are available from General Radio at $1.00 each, postpaid in the United States and Canada.

West Concord, Massachusetts USA 01781
Form 1560-0260-C
ID-935
January, 1969

specifications

Gain: 1:1 or 10:1 (20 dB) ±0.3 dB at 25°C; <±0.3 dB gain change −50°C to +55°C.

Input Capacitance: 6 pF.

Input Resistance: >500 MΩ at low audio frequencies.

Output Resistance: 1:1 gain — approx 20 Ω in series with 3.3 μF.
10:1 gain — approx 100 Ω in series with 3.3 μF.

Noise: ≤2.5 μV equivalent input voltage (400-pF source impedance, C-weighted, 10-kHz effective bandwidth).

Frequency Response (at 0.5 V pk-pk open-circuit output):

1:1 gain

0°C to 55°C	±1.5 dB ±0.25 dB	1 Hz to 500 kHz 3 Hz to 500 kHz
−30°C to 55°C	±1 dB ±0.25 dB	5 Hz to 500 kHz 20 Hz to 500 kHz
10:1 gain		
−30°C to 55°C	±3 dB ±1.5 dB ±0.25 dB	3 Hz to 500 kHz 5 Hz to 500 kHz 20 Hz to 250 kHz

Harmonic Distortion at Audio Frequencies:
Open circuit, at 1 V pk-pk: <0.25%.
Capacitor load of 0.01 μF (equivalent to a cable over 200 ft long): Max output (pk-pk) at 1% distortion is 5 V for 1 kHz, 2 V for 10 kHz.

Accessories Available (supplied in combinations listed below): Power supply, includes two 9.6-V nickel-cadmium rechargeable batteries, a charging circuit, a battery-check light, and a power cord.

Types 1560-P96, 1560-P97, and 1560-P98 Adaptors for converting the input pin connections to 3-terminal shielded microphone connectors, to the pin sockets necessary for the cartridge of a 1560-P3 Microphone, and to a GR874 connector, respectively.

Types 1560-P72 (25-ft), 1560-P72B (100-ft), and 1560-P72C (4-ft) cables for supplying power to and transferring the signal from the preamplifier.

Type 1560-P95 Adaptor Cable for connecting the signal from the power supply through a cable to a double plug.

Type 1560-P99 Adaptor Cable for connection from phone plug to microphone plug.

Power Required: 15 to 25 V, 1 to 2 mA, dc; available from power supply listed below, or from 1558, 1568, and 1564 analyzers, 1525 Recorder, and 1561 Sound-Level Meter.

Dimensions: Length 6⅞, diameter 1.155 by 1 in. (175 x 30 x 26 mm).

Weight: Net, 9 oz (0.3 kg); shipping, 3 lb (1.4 kg), preamplifier only.

Descriptions of the accessories for the preamplifier and a list of the available combination sets are included in the Appendix of this book.

TABLE OF CONTENTS

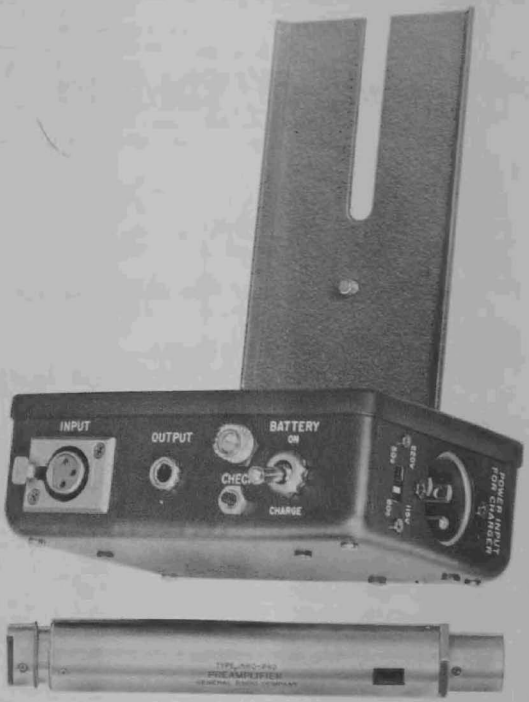


Figure 1-1. Type 1560-P40 Preamplifier with Type 1560-4100 Power Supply and mounting bracket.

SECTION **1**

INTRODUCTION

1.1 PURPOSE.

The Type 1560-P40 Preamplifier (Figure 1-1) is a low-noise amplifier designed to couple a microphone to a coaxial cable without loss or with a voltage gain of 10 to 1. It is also useful as a calibrated preamplifier of signals to analyzers, voltmeters, recorders, sound-level meters, and other such instruments. With the adaptors supplied and available, nearly all types of connectors can be connected to the input of the preamplifier.

A shielded battery power supply, Type 1560-4100 (Figure 1-1) is available to supply power to the Type 1560-P40 Preamplifier for those applications where no other suitable source of power is available.

1.2 MECHANICAL DESCRIPTION.

1.2.1 PREAMPLIFIER.

The preamplifier is housed in a one-inch-diameter tube that is finished in brushed chrome. A one-inch hexagonal section on one end prevents the preamplifier from rolling when it is placed on a flat surface. When a microphone is mounted directly on the input end of the preamplifier, diffraction and reflection of acoustic energy are minimized by the small diameter of the tube.

The cartridge of the General Radio Type 1560-P5 Microphone can be attached directly to the input end of the preamplifier. A groove on the end piece enables the preamplifier and microphone to be attached to the General Radio Type 1559-A or -B Microphone Reciprocity Calibrator for direct acoustical calibration of the microphone and preamplifier or of the complete measurement system. An adaptor is available to mount the cartridge of the Type 1560-P3 Microphone solidly on the preamplifier without inserting a three-terminal microphone connector between the

cartridge and the preamplifier input terminals. Also, this combination of microphone, adaptor, and preamplifier can be attached to the Type 1559-A or -B Microphone Reciprocity Calibrator. Other adaptors are available to adapt the input to three-terminal microphone connectors and to the GR874 Coaxila Connectors. Thus, by means of the various GR874 Adaptors, it is possible to connect the input end of the preamplifier to almost any available type of connector.

1.2.2 POWER SUPPLY.

The Type 1560-4100 Power Supply includes two nickel-cadmium rechargeable batteries, a battery-charging circuit, and a battery-checking circuit, all enclosed in an aluminum case. The controls (see Figure 1-2) include a toggle switch (engraved BATTERY ON and CHARGE), a push-button switch (engraved BATTERY CHECK) with an indicator lamp, and a recessed slide switch to set to the correct power-line voltage for battery charging. A bracket is supplied to attach the power supply to any of several portable GR instruments.

The power supply is available with the preamplifier in the Type 1560-P40H Preamplifier and Power Supply Set, which includes the necessary adaptors and cables. (Other available sets are listed on page 23).

1.3 ELECTRICAL DESCRIPTION.

Two pins of a three-terminal microphone connector at the output end of the preamplifier connect to the preamplifier output; the third pin is used to feed power to the circuit.

The active elements of the preamplifier are: one N-channel, field-effect transistor and two conventional transistors. The field-effect transistor, specially selected for low noise, is connected as a source follower and feeds the two conventional transistors, which are connected as a negative-feedback pair. The feedback is switched to provide a voltage gain of either 1 or 10.

Figure 1-2. Type 1560-4100 Power Supply showing panel controls and method of attaching bracket.

SECTION **2**

SUPPLYING POWER FOR THE PREAMPLIFIER

2.1 GENERAL.

The power required by the preamplifier is 15 to 25 volts at 1 or 2 milliamperes. Types 1558-A, AP, and BP Octave-Band Noise Analyzers, and the Type 1564-A Sound and Vibration Analyzers of current manufacture are designed to provide the power necessary for the Type 1560-P40 Preamplifier from their three-terminal input connectors. The preamplifier can be plugged directly into the connector, or a two-conductor shielded cable, such as those of the Type 1560-P72 series, can be used. Older instruments of the above types, and the Type 1551-C Sound-Level Meter and the Type 1553-A Vibration Meter do not ordinarily supply the required power, but they can be modified as described below (refer to paragraphs 2.3 through 2.5).

2.2 TYPE 1560-4100 POWER SUPPLY.

2.2.1 BATTERY CHARGING.

Always check the battery voltage before using the Type 1560-4100 Power Supply to power the Type 1560-P40 Preamplifier. Set the BATTERY toggle switch to ON. Push the BATTERY CHECK switch. If the indicator lamp does not light, or if it glows for only a short time, the batteries should be recharged. The indicator lamp will not light when the battery voltage drops below 16 volts.

To charge the batteries, set the power-line switch to the voltage and frequency of the available power line. Connect the power supply to the line using the cord provided, then set the toggle switch to CHARGE. Discharged batteries can be fully recharged in 14 to 16 hours.

NOTE

If the power-line rating is 115 volts and 50 c/s instead of 60 c/s, the battery charging current will be low; discharged batteries can be fully recharged in 17 to 20 hours. The charging current can be increased to the nominal 22 mA by changing resistor R501 (Figure 4-1) to 1800 ohms, 2 watts.

If the power-line rating is 230 volts and 60 c/s instead of 50 c/s, the charging current will be too high. Resistor R505 (Figure 4-1) must be increased to 9100 ohms, 5 watts, if frequent recharging at this line voltage and frequency is necessary.

2.2.2 USE OF THE POWER SUPPLY.

The output connector of the Type 1560-P40 Preamplifier can be plugged directly into the INPUT socket of the Type 1560-4100 Power Supply or connected to it with a two-conductor shielded cable. Power is applied to the preamplifier when the BATTERY switch is in the ON position; the power is disconnected when the switch is in the CHARGE position.

The output signal from the preamplifier is accessible at the OUTPUT phone jack on the power supply. The jack can be connected to Type 938 Binding Posts by means of the Type 1560-P95 Cable, or to a three-terminal microphone connector by means of the Type 1560-P99 Cable. A Type 874-Q2 Adaptor, with a Type 1560-P95 Cable, makes it possible to connect the phone jack to a GR874 Coaxial Connector.

2.2.3 ATTACHING THE POWER SUPPLY.

The Type 1560-4100 Power Supply can be attached to several portable General Radio instruments by means of the bracket that is supplied. The procedure is as follows:

a. Remove the four screws that fasten the bottom plate to the power supply.

b. Place the flat plate section of the bracket over the bottom plate, with the slotted leg to the rear (see Figure 1-2), and fasten the two plates to the power supply with the four screws.

c. Lock the Flip-Tilt cover of the instrument to which the power supply is to be attached in the fully open position.

d. Place the power supply beside the instrument, with the slot in the bracket over the tripod socket on the cover of the instrument. Clamp the bracket in the desired position; use the thumbscrew supplied. With the adaptor provided, the thumbscrew may be used with either a 1/4- or 3/8-inch tripod socket.

2.3 POWER SUPPLIED BY TYPE 1551-C SOUND-LEVEL METER OR TYPE 1553-A VIBRATION METER.

The Type 1551-C Sound-Level Meter and the Type 1553-A Vibration Meter are not normally provided with this power capability. However, it can be added if required, preferably by a General Radio service facility. For more detailed information about this modification, write or phone the nearest General Radio sales-engineering office.

2.4 POWER SUPPLIED BY TYPE 1558 OCTAVE-BAND NOISE ANALYZER.

Type 1558-A or -AP Octave-Band Noise Analyzers supplied prior to August, 1964, are not wired to provide power for the preamplifier. These instruments will be modified, without charge, at any General Radio sales office that includes a service facility (see back cover), to provide the required power at the input connector. The modification can be made by connecting a lead from the positive end of capacitor C501 to terminal #2 of the MIKE socket (refer to the Operating Instructions for the Type 1558 Octave-Band Noise Analyzers, Figures 4-3 and 4-7).

2.5 POWER SUPPLIED BY TYPE 1564-A SOUND AND VIBRATION ANALYZER.

Type 1564-A Sound and Vibration Analyzers supplied prior to February, 1965, are not wired to supply power for the preamplifier. It is recommended that these instruments be returned to a General Radio sales-engineering office that includes a service facility, for no-charge modification to provide the required power. However, a modification kit consisting of a lead, a resistor (240 ohms ±5%, 1/2 watt), and a transistor (Type 2N697) will be supplied without charge by any General Radio sales-engineering office.

Figure 2-1 shows the placement of the resistor and lead. Solder one end of the resistor to terminal #2 of the INPUT socket. Connect the lead from the other end of the resistor to the etched-board lead that connects to the emitter of transistor Q505. Replace this transistor with the Type 2N697 transistor supplied in the modification kit.

2.6 OTHER INSTRUMENTS.

The dc power to operate the Preamplifier can be obtained directly from the Type 1568 Wave Analyzer, Type 1525 Data Recorder and the Type 1561 Precision Sound-Level Meter.

CAUTION

Terminal #2 is connected to ground (terminal #1) on the connectors of some microphones, accelerometers, control boxes, and cables supplied by General Radio prior to January, 1962. If necessary, remove the connection between pins #1 and #2 before the above connectors are plugged into any other connector that supplies power through pin #2.

Figure 2-1. Modification of Type 1564-A Sound and Vibration Analyzer for use with the preamplifier.

SECTION 3

OPERATING PROCEDURE

3.1 MICROPHONE OR ADAPTOR ATTACHMENT.

The cartridge of the Type 1560-P3 Microphone and the Types 1560-P96, -P97, and -P98 Adaptors can be locked to the preamplifier by backing out two shouldered screws against the cartridge or the adaptor. Use the following procedure:

a. Turn in the two screws (A, Figure 3-1), using the hexagonal wrench provided.

b. Plug the microphone or adaptor into the preamplifier so that the red dots (engraved on the sides of each) are aligned.

c. Back out the two screws so that their tips extend through the holes in the microphone or adaptor and their shoulders press firmly against the shell.

If the Type 1560-P3 Microphone is to be used with the preamplifier it can be attached by use of the Type 1560-P96 Adaptor for three-terminal microphone connectors; or the microphone cartridge can be removed from the connector section and attached to the Type 1560-P97 Adaptor. The latter combination is preferable, because it eliminates the electrical noise development that may occur in the three-terminal connectors when they are used in a high-impedance circuit.

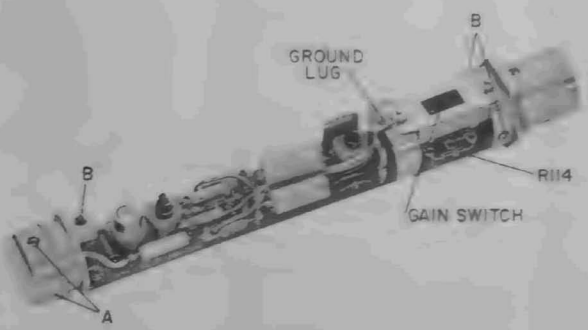


Figure 3-1. Interior view of the preamplifier.

To attach the microphone cartridge to the Type 1560-P97 Adaptor, proceed as follows:

a. Remove the three screws that attach the microphone cartridge to the Type 1560-P3 Microphone.

b. Lift off the cartridge; unclip the leads from the two connecting pins on the cartridge.

c. Plug the cartridge onto the Type 1560-P97 Adaptor and fasten it with the three screws removed in step a.

If the microphone cartridge is reassembled on the three-terminal microphone connector, the two pins must be connected correctly. Connect the lead from connector pin #1 to the grounded pin (no insulator) of the microphone cartridge.

NOTE

Cartridges for the Type 1560-P3 Microphones that have connecting leads instead of pins on the cartridge cannot be used with the Type 1560-P97 Adaptor.

3.2 MICROPHONE-SENSITIVITY CORRECTION.

When a microphone and preamplifier are used in conjunction with a Type 1551-C Sound-Level Meter, a Type 1558-A Octave-Band Noise Analyzer, or a Type 1564-A Sound and Vibration Analyzer, the effective sensitivity of the microphone is increased. This increase is brought about because the voltage loss caused by the preamplifier input-capacitance load on the microphone is less than that caused by the input-capacitance load of the above instruments. Also, when a cartridge from a Type 1560-P4 or -P6 Microphone Assembly is used, the loss caused by the capacitance of the flexible arm is not present. (The sensitivity given for a Type 1560-P4 or -P6 Microphone Assembly is for the combined microphone cartridge and flexible arm.)

To calibrate a system of microphone, preamplifier, and one of the above-named instruments, a Type 1552-B Sound-Level Calibrator or a Type 1559-B Microphone Reciprocity Calibrator is recommended. Alternatively, the correction data given in Table 3-1 can be used to correct the

TABLE 3-1

MICROPHONE-SENSITIVITY CORRECTION IN DECIBELS

	Measuring Instrument		
Microphone Cartridge	*Type 1551-C*	*Type 1558-A, -AP*	*Type 1564-A*
Type 1560-P3 or -P5	0.9	1.0	1.4
Type 1560-P4 or -P6	1.5	1.6	2.1

sensitivity value given for the particular microphone being used. Add the correction algebraically to the specified microphone sensitivity value to obtain the effective sensitivity value. This corrected value can then be used to calibrate the measuring instrument, as directed in the Operating Instructions for the latter. If a Type 1552-B Sound-Level Calibrator is used to calibrate the system, the gain of the preamplifier should be set at X1, to prevent its possible overload (see Figure 3-2). If the system is calibrated with a Type 1559-B Microphone Reciprocity Calibrator, the preamplifier gain may be set at either X1 or X10.

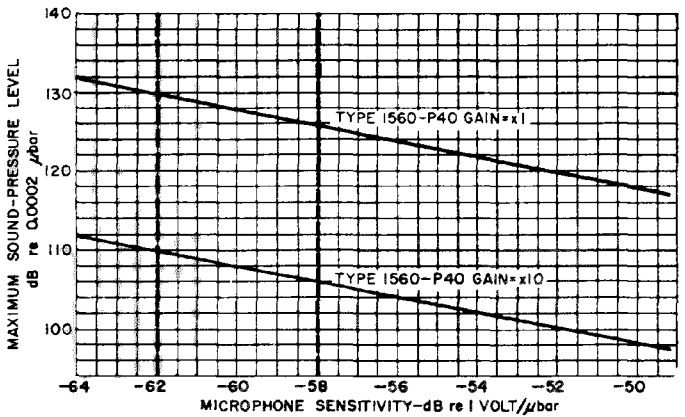


Figure 3-2. Maximum sound-pressure level that can be measured with a Type 1560-P40 Preamplifier and microphone combination. The sensitivities of Types 1560-P3, -P4, -P5, and -P6 Microphones will fall between the dotted lines. Allowance is made for a peak-to-rms ratio of 14 dB. For a sine-wave acoustic signal, the maximum level can be increased by 11 dB.

3.3 ELECTRICAL-SIGNAL MEASUREMENTS.

3.3.1 GENERAL.

Connect the preamplifier to its source of power (refer to Section 2) and connect the input signal to the preamplifier by means of the correct adapter. Set the gain switch (see Figure 3-1) to the desired gain, either **X1 or X10, as engraved on the switch.**

NOTE

When power is applied to the preamplifier, about one-half minute is required for the input stage to stabilize and for the preamplifier to operate.

With a high-impedance load on the preamplifier, audio-frequency voltage up to 0.5 volt peak-to-peak at X10 gain or 5 volts peak-to-peak at X1 gain may be applied to the preamplifier input.

Because of the low output impedance of the preamplifier, a long cable may be used between the preamplifier and the measuring instrument. At X10 gain, up to one-half mile of cable may be used; at X1 gain, up to one mile is satisfactory. Figure 3-3 shows the attenuation versus frequency for three different lengths of cable. The fixed loss for each length

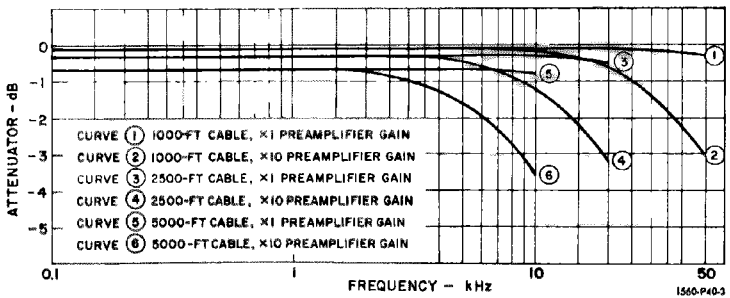


Figure 3-3. Attenuation of the preamplifier output signal caused by the capacitance of the cable between the preamplifier and the measuring instrument.

is caused by the divider formed by the preamplifier output coupling capacitor and the cable capacitance. When a long connecting cable is used, output from the preamplifier may have to be restricted because of the low reactance load of the cable. Figure 3-4 shows cable length versus maximum voltage output at three different frequencies, for a maximum distortion of 1%. The maximum sound-pressure level that should be measured is also shown.

A restricting factor in the use of long cables is the fact that as the length of a cable terminated in a high impedance approaches 1/4 wavelength of the electrical-signal frequency, the amplitude and transient response at the output end will be considerably distorted.

Figure 3-5 gives the noise level of the preamplifier in the form of curves of typical values for the e_n and i_n generators versus frequency.

Figures 3-6 and 3-7 give the phase shift in the amplifier as a function of frequency.

3.3.2 GROUNDING.

Normally, the low side of the preamplifier circuit is connected to the shell, which may be grounded by the ground of the measuring system. Occasionally, however, problems arise from multiple ground loops caused by grounds at different points in a system. As an aid in solving such special problems, the grounding connection from the preamplifier circuit to the shell can be disconnected easily. Remove the cylindrical tube from

Figure [illegible]. Curves showing the maximum output for a maximum transient of one microsecond when a step voltage terminated at a high impedance load is driven. Allowance is made on the maximum recommended value to be allowable maximum because a pedestal as much as [illegible] volts above the maximum signal. The maximum signal pedestal level can be increased to [illegible] volts.

Figure [illegible]. Typical transient waveform of received pulse.

the preamplifier (refer to paragraph 4.3.2). Then remove the screw holding the ground lug at the end of the gain switch (see Figure 3-1). Bend the connecting lead so that the lug can not contact the shell or any part of the circuit. Then replace the screw. Also, be sure that the circuit is not grounded to the shell by the input or output connector. If cable connections are used, a two-conductor shielded cable for the input and a three-conductor shielded cable for the output are required. The shields must connect to the shell. The low side of the preamplifier circuit connects to terminal #1 of the three-terminal output plug.

3.4 ACOUSTIC MEASUREMENTS.

In acoustic measurements, the preamplifier can be used to increase by 20 dB the sensitivity of the Types 1558-A, 1558-AP, and 1564 Analyzers. In conjunction with the preamplifier, these instruments can be used for measurements down to a sound-pressure level of 24 dB re .0002 μbar.

The preamplifier is also useful with the Type 1551-C, 1561, and 1561-R Sound-Level Meters, as well as with the above instruments, when a long cable must be used. The preamplifier eliminates the loss caused by a long cable used directly after a microphone (refer to paragraph 3.3.1).

The 1569 Automatic Level Regulator can also be used with the preamplifier.

Attach the microphone to the preamplifier as described in paragraph 3.1. Connect the preamplifier to its power source and to the measuring instrument (which may also be the power source; refer to paragraphs 2.3 through 2.5). Slide the gain switch (see Figure 3-1) to the desired gain, X1 or X10, as engraved on the switch. When the gain is X10, subtract 20 dB from the decibel reading of the measuring instrument to obtain the noise level at the microphone.

When a cable is used to connect them to the measuring instrument, the preamplifier and microphone can be mounted on the Type 1560-P32 Tripod. The measuring instrument and the observer can then be located at the other end of the cable, far enough removed from the acoustic field to have little or no effect on the accuracy of the measurement.

When a short connecting cable, or none at all, is used, the maximum noise level that can be measured without the possibility of overloading the amplifier is given in Figure 3-2. Allowance is made for a peak-to-rms ratio of 14 dB, which is adequate for normal noise.

When a long connecting cable is used, the maximum noise level that should be measured is given in Figure 3-4. The maximum value obtained from the figure will usually be pessimistic for broadband noise measurements, since the high-frequency components of such noise usually are of lower level than the low-frequency components.

For a complete discussion of the techniques of noise measurement, refer to the General Radio Handbook of Noise Measurement.

NOTE

When the preamplifier-and-microphone assembly is used, particularly when low sound levels are measured, the assembly should be protected from mechanical vibration, such as that cuased by rubbing against another object. The vibration is transmitted through the mechanical structure to the microphone, and the resulting electrical signal from the microphone may cause a large error in the measurement.

3.5 VIBRATION MEASUREMENTS.

The preamplifier can be used to advantage with the Type 1553 Vibration Meter and the Type 1564-A Sound and Vibration Analyzer for vibration measurement and analysis. It permits the use of long cables without loss and increases the sensitivity of the measuring instrument by 20 dB.

Attach the Type 1560-P96 Adaptor to the preamplifier as described in paragraph 3.1. Plug the vibration-pickup cable into the adaptor. Connect the preamplifier to its power source and to the measuring instrument (refer to paragraphs 2.3 through 2.5). Slide the gain switch to the desired gain (X1 or X10). If the preamplifier is used at X10 gain, divide the readings of the measuring instrument by 10. If readings are taken in decibels, subtract 20 dB. Allowance is made for a peak-to-rms ratio of approximately 15 dB. For a sine-wave vibration signal, the maximum g values given can be multiplied by 4.

Table 3-2 lists the maximum vibration acceleration that should be measured when General Radio vibration pickups are used with the Type 1560-P40 Preamplifier.

The Type 1557-A Vibration Calibrator can be used to calibrate the Types 1560-P52 and -P53 Pickups with either X1 or X10 preamplifier gain. The Type 1560-P54 Pickup should be calibrated only with X1 gain.

3.6 OTHER APPLICATIONS.

The preamplifier provides added sensitivity, at a very high input impedance, to a wide variety of instruments. These instruments are listed in Table 3-3. The Type 1560-4100 Power Supply is required when the preamplifier is used with any of these instruments.

TABLE 3-2

MAXIMUM VIBRATION ACCELERATION TO BE MEASURED WITH VARIOUS PICKUPS.

Pickup	*X1 Preamplifier Gain*	*X10 Preamplifier Gain*
Type 1560-P52	5.5 g	0.55 g
Type 1560-P53	5.5 g	0.55 g
Type 1560-P54	0.7 g	0.070 g

TABLE 3-3

INSTRUMENTS WITH WHICH THE TYPE 1560-P40 PREAMPLIFIER (WITH THE TYPE 1560-4100 POWER SUPPLY) CAN BE USED FOR ADDED SENSITIVITY.

Type No.	*Name*
1900-A	Wave Analyzer
*1565-A	Sound-Level Meter
1142-A	Frequency Meter and Discriminator
1232-A	Tuned Amplifier and Null Detector
1521-B	Graphic Level Recorder
1806-A	Electronic Voltmeter

*Use a 1560-P96 Adaptor at input to 1565-A; connect a 390-PF ±5% capacitor in series with lead to #3 input terminal.

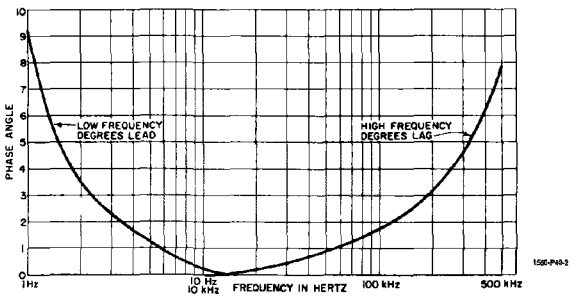


Figure 3-6. Phase shift in the 1560-P40 Preamplifier at 0 dB gain. High-impedance load.

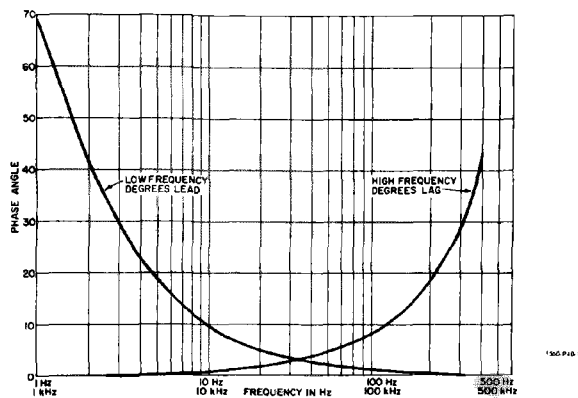


Figure 3-7. Phase shift in the 1560-P40 Preamplifier at 20 dB gain. High-impedance load.

SECTION **4**

SERVICE AND MAINTENANCE

4.1 WARRANTY.

We warrant that each new instrument sold by us is free from defects in material and workmanship, and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, sales-engineering office, or authorized repair-agency personnel, will be repaired, or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

4.2 SERVICE.

The two-year warranty stated above attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone our Service Department (see rear cover), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial and type numbers of the instrument.

Before returning an instrument to General Radio for service, please write to our Service Department or nearest sales-engineering office, requesting a Returned Material Tag. Use of this tag will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

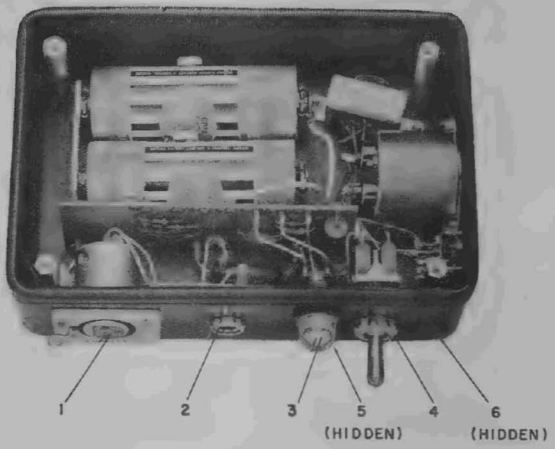


Figure 4-1. Interior view of the power supply.

4.3 SERVICING.

4.3.1 TYPE 1560-4100 POWER SUPPLY.

Remove the four screws that attach the bracket and the cover plate and remove the bracket and plate. Figures 4-1 and 4-4 show the locations of all components.

Table 4-1 gives the normal voltage from each transistor terminal to ground. Depress the BATTERY CHECK button. Measure the voltages with a vacuum-tube voltmeter and with a battery voltage of about 21 volts (nearly fully charged). A 10-percent deviation from the listed values is allowable.

At nominal line voltage (marked on the case, near the line-voltage switch), the battery-charging current should be 22 milliamperes ±10%. Measure the current with an average-reading dc meter.

TABLE 4-1

POWER SUPPLY TRANSISTOR VOLTAGES.

Transistor	*Terminal*	*Dc Volts to Ground*
Q501	COLLECTOR	6.9
	BASE	7.4
	EMITTER	6.8

4.3.2 TYPE 1560-P40 PREAMPLIFIER.

Using the hexagonal wrench provided, screw in the three shouldered screws (B, Figure 3-1) until the cylindrical tube can be removed from the preamplifier. Figures 3-1 and 4-2 show the locations of the components.

Table 4-2 lists normal voltages from each transistor to ground. Measure the voltages with a vacuum-tube voltmeter and with a battery voltage of 21 volts. A 10-percent deviation from the listed values is allowable.

TABLE 4-2

PREAMPLIFIER TRANSISTOR VOLTAGES.

Transistor	*Terminal*	*Dc Volts to Ground*
Q101	DRAIN	21.0
	SOURCE	8.0
	GATE	8.1
Q102	COLLECTOR	16.6
	BASE	8.0
	EMITTER	7.5
Q103	COLLECTOR	11.5
	BASE	7.9
	EMITTER	7.3

Before making measurements, short-circuit the preamplifier input terminals. Install a resistor of about 10 megohms across resistor R101 (see Figures 4-2 and 4-3). If such a resistor is not available, momentarily short-circuit R101 before any voltages are measured. Do not attempt to measure the voltage from the gate of Q101 to ground without a shunt across resistor R101.

4.3.3 BATTERIES.

The Power supply is shipped with two 9.6-V batteries (Gould Type 9.6 V/225 B, or equivalent) installed.

MECHANICAL PARTS LIST

Ref. No.	Name	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
1	INPUT	Socket	4230-2693	24655	4230-2693	5935-911-2792
2	———	Dress Nut, 3/8, 7/16	5800-0805	24655	5800-0805	
3	———	Pilot Light, Lamp	5600-0314	71744	#344	6210-082-0583
4	———	Dress Nut, 15/32-32, 7/16	5800-0800	24655	5800-0800	5310-344-3644
5	CHECK	Switch	7870-1120	81073	30-1 N.O.	
6	———	Foot, Rigid, Stainless Steel	5250-1600	24655	5250-1600	

TYPE 1560-P40 PREAMPLIFIER PARTS LIST

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
CAPACITORS					
C101	Plastic, 0.0022 μF ±2% 200 V	4860-7326	84411	663UW, 0.0022 μF ±2%	
C102	Electrolytic, 22 μF ±20% 15 V	4450-5300	56289	150D226X0015B2	5910-752-4270
C103	Electrolytic, 120 μF ±20% 10 V	4450-5616	56289	150D127X0010R2	
C104	Electrolytic, 120 μF ±20% 10 V	4450-5616	56289	150D127X0010R2	
C105	Electrolytic, 120 μF ±20% 10 V	4450-5616	56289	150D127X0010R2	
C106	Ceramic, 3.3 μF ±20% 15 V	4450-4600	56289	150D335X0015A2	5910-837-9325
RESISTORS					
R101	Composition, 1 GΩ ±20% 1/2 W	6100-8108	01121	EB, 1 GΩ ±20%	
R102	Composition, 27 kΩ to 150 kΩ±5% 1/4 W	6099- *	75042		
R103	Composition, 20 kΩ ±5% 1/4 W	6099-3205	75042	BTS, 20 kΩ ±5%	5905-686-3368
R104	Composition, 56 kΩ ±5% 1/4 W	6099-3565	75042	BTS, 56 kΩ ±5%	5905-800-0179
R105	Composition, 51 kΩ ±5% 1/4 W	6099-3515	75042	BTS, 51 kΩ ±5%	5905-200-6731
R106	Composition, 3 kΩ ±5% 1/4 W	6099-2305	75042	BTS, 3 kΩ ±5%	5905-682-4097
R107	Film, 0.976 kΩ to 1.07 kΩ ±1% 1/8 W	6250- *	75042		
R108	Composition, 150 kΩ ±5% 1/4 W	6099-4155	75042	BTS, 150 kΩ ±5%	5905-686-9995
R109	Film, 9.53 kΩ ±1% 1/8 W	6250-1953	75042	CEA, 9.53 kΩ ±1%	5905-755-2759
R110	Composition, 39 Ω to 270 Ω ±5% 1/4 W	6099- *	75042		
R111	Composition, 8.2 kΩ ±5% 1/4 W	6099-2825	75042	BTS, 8.2 kΩ ±5%	
R112	Composition, 6.2 kΩ ±5% 1/4 W	6099-2625	75042	BTS, 6.2 kΩ ±5%	5905-682-4100
R113	Composition, 470 kΩ ±5% 1/4 W	6099-4475	75042	BTS, 470 kΩ ±5%	
R114	Composition, 15 Ω ±5% 1/4 W	6099-0155	75042	BTS, 15 Ω ±5%	
MISCELLANEOUS					
PL101	Plug	4220-5306	82389	G-4281	
SO101	Socket	1560-1400	24655	1560-1400	
S101	Switch, Toggle	7910-0830	82389	4663	
Q101	Transistor, C6601A	8210-1082	94589	D3068A	
Q102	Transistor, 2N3391A	8210-1092	24454	2N3391A	
Q103	Transistor, 4JX16A733	8210-1083	24454	4JX16A733	
TO168	Wrench	7985-1680	24655	7985-1680	
Spare Setscrews		1560-6250	24655	1560-6250	

*Value determined by General Radio Laboratory.

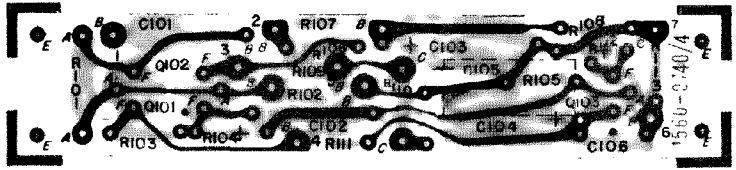


Figure 4-2. Etched-board layout for the Type 1560-P40 Preamplifier.

NOTE

The number shown on the foil side of the board is not the part number for the complete assembly. The assembly number is 1560-2741.

NOTE UNLESS SPECIFIED

1 POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE
2 CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK
3 REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM
4 RESISTORS 1/4 WATT
5 RESISTANCE IN OHMS K = 1000 OHMS M = 1 MEGOHM G = GIGOHM = 1000 MEGOHMS
6 CAPACITANCE VALUES ONE AND OVER IN PICOFARADS, LESS THAN ONE IN MICROFARADS
7 KNOB CONTROL
8 SCREWDRIVER CONTROL
9 AT ANCHOR TERMINAL
10 TP TEST POINT

ANCHOR TERMINALS USED A.T. 1-9

*VALUE DETERMINED BY LAB

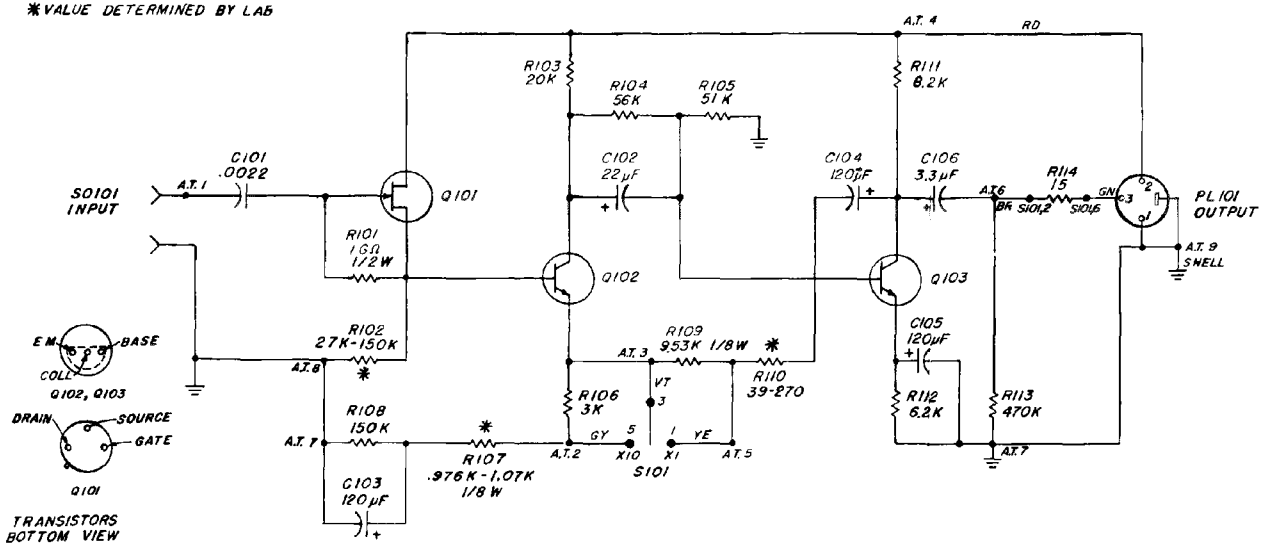


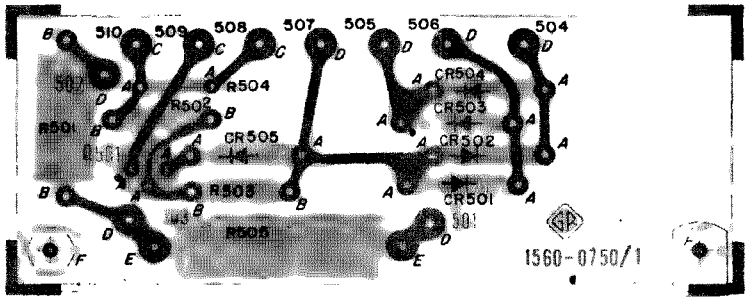
Figure 4-3. Schematic diagram for the Type 1560-P40 Preamplifier.

Value determined by General Radio Laboratory.

TYPE 1560-4100 POWER SUPPLY

PARTS LIST

Ref. No.	Description	GR Part No.	Fed. Mfg. Code	Mfg. Part No.	Fed. Stock No.
RESISTORS					
R501	Composition, 2.7 kΩ ±5% 2 W	6120-2275	01121	HB, 2.7 kΩ ±5%	
R502	Film, 7.68 kΩ ±1% 1/8 W	6250-1768	75042	CEA, 7.68 kΩ ±1%	5905-978-8817
R503	Film, 7.15 kΩ ±1% 1/8 W	6250-1715	75042	CEA, 7.15 kΩ ±1%	5905-815-3793
R504	Composition, 300 Ω ±5% 1/4 W	6099-1305	75042	BTS, 300 Ω ±5%	5905-279-5481
R505	Power, 6.8 kΩ ±5% 5 W	6660-2685	80183	246E, 6.8 kΩ ±5%	
MISCELLANEOUS					
B501	Battery, 9.6 V	8410-1040	09823	CD25	
B502	Battery, 9.6 V	8410-1040	09823	CD25	
CR501	Diode, 1N645	6082-1016	24446	1N645	5961-944-8222
CR502	Diode, 1N645	6082-1016	24446	1N645	5961-944-8222
CR503	Diode, 1N645	6082-1016	24446	1N645	5961-944-8222
CR504	Diode 1N645	6082-1016	24446	1N645	5961-944-8222
CR505	Diode, 1N957B	6083-1009	07910	1N957B	
J501	Jack, Output	4260-1030	82389	#111	
P501	Lamp, 10 V	5600-0314	71744	#344	6210-082-0583
PL501	Plug, Power, Input for Charger	4240-0702	24655	4240-0702	5935-993-9847
SO501	Socket, Input	4230-2693	24655	4230-2693	5935-911-2792
S501	Switch, Battery On/Charge	7910-1500	04009	83054-SA	5930-797-3760
S502	Switch, Check	7870-1120	81073	30-1 N.O.	
S503	Switch, Line Voltage Selector	7910-0831	42190	4603	
Q501	Transistor, 2N2714	8210-1047	24446	2N3416	5961-989-2749
T501	Transformer	0748-4000	24655	0748-4000	
CAP22	Power Cable	4200-9622	24655	4200-9622	6150-968-0081



NOTE

The number shown on the foil side of the board is not the part number for the complete assembly. The assembly number is 1560-2751.

Figure 4-4. Etched-board layout for the Type 1560-4100 Power Supply.

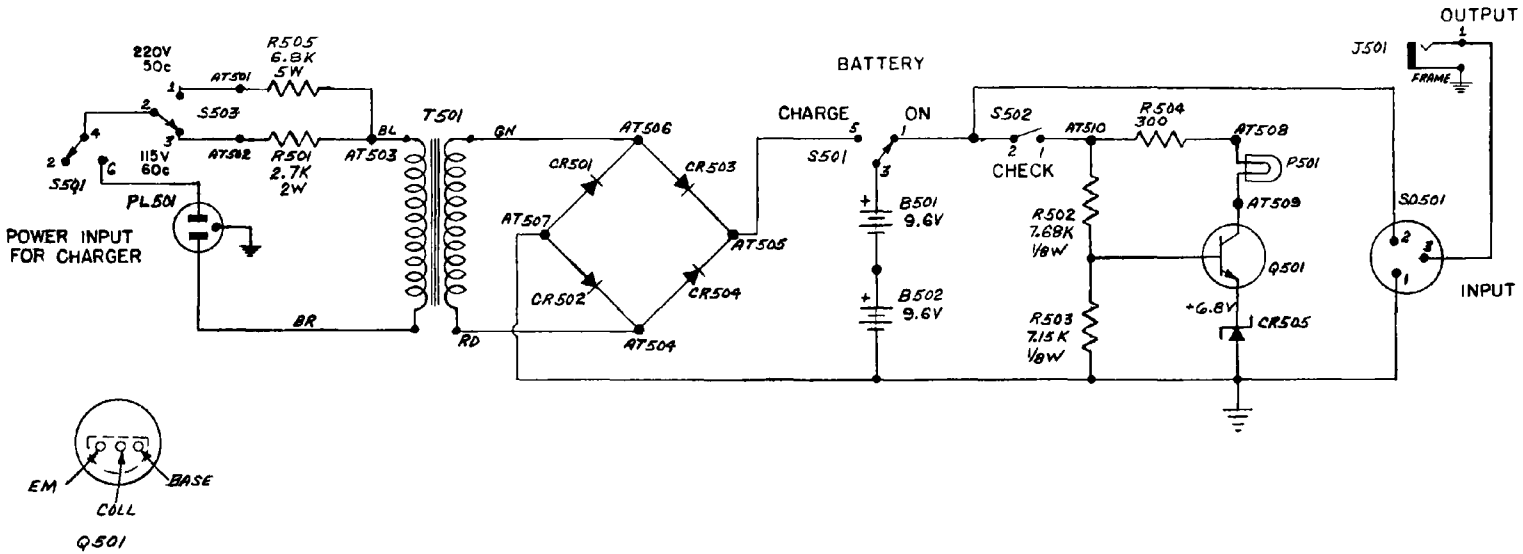


Figure 4-5. Schematic diagram for the Type 1560-4100 Power Supply.

APPENDIX

CABLES AND ADAPTORS FOR USE WITH THE TYPE 1560-P40 PREAMPLIFIER

Type 1560-P72, 25-foot Cable

Connects the preamplifier to the Type 1560-4100 Power Supply or measuring instrument supplying power; also carries output signal from the preamplifier to a phone jack on the Type 1560-4100 Power Supply or to the measuring instrument.

Type 1560-P72C, 4-foot Cable

Same as Type 1560-P72 Cable, above, except for length.

Type 1560-P95 Adaptor Cable

Provides means of connecting the preamplifier output signal from a jack on the Type 1560-4100 Power Supply, through a cable, to a Type 274-M Double Plug.

Type 1560-P99 Adaptor Cable

Cable with phone plug on one end and 3-terminal, shielded, audio connector on the other.

Type 1560-P96 Adaptor

Adapts preamplifier input to 3-terminal, shielded audio connector.

Type 1560-P97 Adaptor

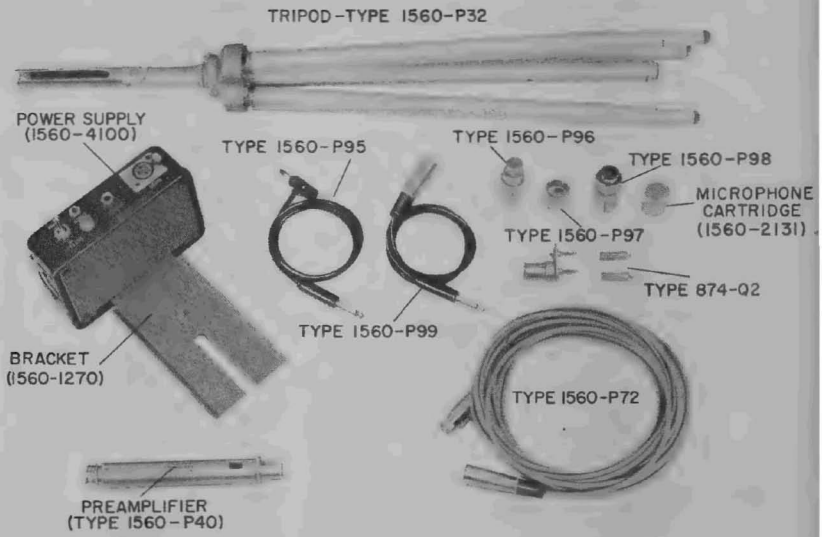
Adapts preamplifier input to cartridge of Type 1560-P3 Microphone.

Type 1560-P98 Adaptor

Adapts preamplifier input to GR874 Coaxial Connector.

Type 874-Q2 Adaptor

Adapts GR874 Coaxial Connector to Type 274 Jacks (banana-pin) on 3/4-inch spacing.



AVAILABLE COMBINATION SETS

The Type 1560-P40 Preamplifier is available with various accessories in the three sets listed below (see figure, page 22).

Type 1560-P40H Preamplifier and Power Supply Set

This set is self-powered; it is independent of any external power supply. It can be used with the Type 1565-A Sound-Level Meter or with any of the instruments listed in Table 3-3.

The following items are included in the Type 1560-P40H Preamplifier and Power Supply Set:

- Type 1560-P40 Preamplifier
- Type 1560-4100 Power Supply
- Type 1560-P96 Adaptor
- Type 1560-P98 Adaptor
- Type 1560-P95 Adaptor Cable
- Type 1560-P99 Adaptor Cable
- Type 1560-P72C 4-foot Cable
- Type 874-Q2 Adaptor
- Carrying Case 1560-0421
- Spare Setscrews 1560-6250
- Wrench 7985-1680

Type 1560-P40J Preamplifier and Adaptor Set

Power for the preamplifier, with this set, must be obtained from the instrument to which the preamplifier is connected, such as the Types 1558 and 1564 Analyzers; other instruments, such as the Type 1551 Sound-Level Meter and the Type 1553 Vibration Meter, must be modified to provide power for the preamplifier (refer to paragraphs 2.3, 2.4, and 2.5). If the source connector is not a type for which an adaptor is supplied, the GR874 Adaptors (listed in the General Radio Catalog) can be used with the Type 1560-P98 Adaptor (supplied) to mate with most standard coaxial connectors.

The following items are included in the Type 1560-P40J Preamplifier and Adaptor Set:

- Type 1560-P40 Preamplifier
- Type 1560-P96 Adaptor
- Type 1560-P97 Adaptor
- Type 1560-P98 Adaptor
- Type 1560-P72C 4-foot Cable
- Carrying Case 1560-0421
- Spare Setscrews 1560-6250
- Wrench 7985-1680

Type 1560-P40K Preamplifier and Microphone Set

This set is intended for use with Types 1558 and 1564 Analyzers when an acoustic measurement is to be made at low levels or when the microphone must be located at the end of a long cable. This set can also be used with a modified Type 1551-C Sound-Level Meter (refer to paragraph 2.3) when a long microphone cable is necessary.

The following items are included in the Type 1560-P40K Preamplifier and Microphone Set:

- Type 1560-P40 Preamplifier
- Type 1560-P72C 4-foot Cable
- Type 1560-P72 25-foot Cable
- Type 1560-P32 Tripod
- Type 1560-2131 Microphone Cartridge
- Carrying Case 1560-0421
- Spare Setscrews 1560-6250
- Wrench 7985-1680

Type 1560-9512 Power Supply Group

The following Power Supply Group is also available:

- Type 1560-4100 Power Supply
- Type CAP-22 Three-wire Power Cord
- Type 1560-1270 Bracket

FEDERAL MANUFACTURER'S CODE

From Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) as supplemented through August, 1968.

Code	Manufacturer
00192	Jones Mfg. Co, Chicago, Illinois
00194	Walsco Electronics Corp, L.A., Calif.
00434	Schweber Electronics, Westburg, L.I., N.Y.
00656	Aerovox Corp, New Bedford, Mass.
01009	Alden Products Co, Brockton, Mass.
01121	Allen-Bradley, Co, Milwaukee, Wisc.
01295	Texas Instruments, Inc, Dallas, Texas
02114	Ferroxcube Corp, Saugerties, N.Y. 12477
02606	Fenwal Lab Inc, Morton Grove, Ill.
02660	Amphenol Electron Corp, Broadview, Ill.
02768	Fastex, Des Plaines, Ill. 60016
03508	G.E. Semicon Prod, Syracuse, N.Y. 13201
03636	Grayburne, Yonkers, N.Y. 10701
03888	Pyrofilm Resistor Co, Cedar Knolls, N.J.
03911	Clairex Corp, New York, N.Y. 10001
04009	Arrow-Hart & Hegeman, Hartford, Conn. 06106
04713	Motorola, Phoenix, Ariz. 85008
05170	Engr'd Electronics, Santa Ana, Calif. 92702
05624	Barber-Colman Co, Rockford, Ill, 61101
05820	Wakefield Eng, Inc, Wakefield, Mass. 01880
07126	Digitron Co, Pasadena, Calif.
07127	Eagle Signal (E.W. Bliss Co), Baraboo, Wisc.
07261	Avnet Corp, Culver City, Calif. 90230
07263	Fairchild Camera, Mountain View, Calif.
07387	Birtcher Corp, No. Los Angeles, Calif.
07595	Amer Semicond, Arlington Hts, Ill. 60004
07828	Bodine Corp, Bridgeport, Conn. 06605
07829	Bodine Electric Co, Chicago, Ill. 60618
07910	Cont Device Corp, Hawthorne, Calif.
07983	State Labs Inc, N.Y., N.Y. 10003
07999	Borg Inst., Delavan, Wisc. 53115
08730	Vemaline Prod Co, Franklin Lakes, N.J.
09213	G.E. Semiconductor, Buffalo, N.Y.
09408	Star-Tronics Inc, Georgetown, Mass. 01830
09823	Burgess Battery Co, Freeport, Ill.
09922	Burndy Corp, Norwalk, Conn. 06852
11236	C.T.S. of Berne, Inc, Berne, Ind. 46711
11599	Chandler Evans Corp, W. Hartford, Conn.
12040	National Semiconductor, Danbury, Conn.
12498	Crystalonics, Cambridge, Mass. 02140
12672	RCA, Woodbridge, N.J.
12697	Clarostat Mfg Co, Inc, Dover, N.H. 03820
12954	Dickson Electronics, Scottsdale, Ariz.
13327	Solitron Devices, Tappan, N.Y. 10983
14433	ITT Semicondictors, W.Palm Beach, Fla.
14655	Cornell-Dubilier Electric Co, Newark, N.J.
14674	Corning Glass Works, Corning, N.Y.
14936	General Instrument Corp, Hicksville, N.Y.
15238	ITT, Semiconductor Div, Lawrence, Mass.
15605	Cutler-Hammer Inc, Milwaukee, Wisc. 53233
16037	Spruce Pine Mica Co, Spruce Pine, N.C.
17771	Singer Co, Diehl Div, Somerville, N.J.
19396	Illinois Tool Works, Pakton Div, Chicago, Ill.
19644	LRC Electronics, Horseheads, N.Y.
19701	Electra Mfg Co, Independence, Kansas 67301
21335	Fafnir Bearing Co, New Briton, Conn.
22753	UID Electronics Corp, Hollywood, Fla.
23342	Avnet Electronics Corp, Franklin Park, Ill.
24446	G.E., Schenectady, N.Y. 12305
24454	G.E., Electronics Comp, Syracuse, N.Y.
24455	G.E. (Lamp Div), Nela Park, Cleveland, Ohio
24655	General Radio Co, W. Concord, Mass. 01781
26806	American Zettler Inc, Costa Mesa, Calif.
28520	Heyman Mfg Co, Kenilworth, N.J.
28959	Hoffman Electronics Corp, El Monte, Calif.
30874	I.B.M, Armonk, New York
32001	Jensen Mfg. Co, Chicago, Ill. 60638
33173	G.E. Comp, Owensboro, Ky. 42301
35929	Constanta Co, Mont. 19, Que.
37942	P.R. Mallory & Co Inc, Indianapolis, Ind.
38443	Marlin-Rockwell Corp, Jamestown, N.Y.
40931	Honeywell Inc, Minneapolis, Minn. 55408
42190	Muter Co, Chicago, Ill. 60638
42498	National Co, Inc, Melrose, Mass. 02176
43991	Norma-Hoffman, Stanford, Conn. 06904

Code	Manufacturer
49671	RCA, New York, N.Y. 10020
49956	Raytheon Mfg Co, Waltham, Mass. 02154
53021	Sangamo Electric Co, Springfield, Ill. 62705
54294	Shallcross Mfg Co, Selma, N.C.
54715	Shure Brothers, Inc, Evanston, Ill.
56289	Sprague Electric Co, N. Adams, Mass.
59730	Thomas and Betts Co, Elizabeth, N.J. 07207
59875	TRW Inc, (Accessories Div), Cleveland, Ohio
60399	Torrington Mfg Co, Torrington, Conn.
61637	Union Carbide Corp, New York, N.Y. 10017
61864	United-Carr Fastener Corp, Boston, Mass.
63060	Victoreen Instrument Co, Inc, Cleveland, O.
63743	Ward Leonard Electric Co, Mt. Vernon, N.Y.
65083	Westinghouse (Lamp Div), Bloomfield, N.J.
65092	Weston Instruments, Newark, N.J.
70485	Atlantic-India Rubber, Chicago, Ill. 60607
70563	Amperite Co, Union City, N.J. 07087
70903	Belden Mfg Co, Chicago, Ill. 60644
71126	Bronson, Homer D, Co, Beacon Falls, Conn.
71294	Canfield, H.O. Co, Clifton Forge, Va. 24422
71400	Bussman (McGraw Edison), St. Louis, Mo.
71468	ITT Cannon Elec, L.A., Calif. 90031
71590	Centralab, Inc, Milwaukee, Wisc. 53212
71666	Continental Carbon Co, Inc, New York, N.Y.
71707	Coto Coil Co Inc, Providence, R.I.
71744	Chicago Miniature Lamp Works, Chicago, Ill.
71785	Cinch Mfg Co, Chicago, Ill. 60624
71823	Darnell Corp, Ltd, Downey, Calif. 90241
72136	Electro Motive Mfg Co, Wilmington, Conn.
72259	Nytronics Inc, Berkeley Heights, N.J. 07922
72619	Dialight Co, Brooklyn, N.Y. 11237
72699	General Instr Corp, Newark, N.J. 07104
72765	Drake Mfg Co, Chicago, Ill. 60656
72825	Hugh H. Eby Inc, Philadelphia, Penn. 19144
72962	Elastic Stop Nut Corp, Union, N.J. 07083
72982	Erie Technological Products Inc, Erie, Penn.
73138	Beckman Inc, Fullerton, Calif. 92634
73445	Amperex Electronics Co, Hicksville, N.Y.
73559	Carling Electric Co, W.Hartford, Conn.
73690	Elco Resistor Co, New York, N.Y.
73899	JFD Electronics Corp, Brooklyn, N.Y.
74193	Heinemann Electric Co, Trenton, N.J.
74861	Industrial Condenser Corp, Chicago, Ill.
74970	E.F. Johnson Co, Waseca, Minn. 56093
75042	IRC Inc, Philadelphia, Penn. 19108
75382	Kulka Electric Corp, Mt. Vernon, N.Y.
75491	Lafayette Industrial Electronics, Jamica, N.Y.
75608	Linden and Co, Providence, R.I.
75915	Littelfuse, Inc, Des Plaines, Ill. 60016
76005	Lord Mfg Co, Erie, Penn. 16512
76149	Mallory Electric Corp, Detroit, Mich. 48204
76487	James Millen Mfg Co, Malden, Mass. 02148
76545	Mueller Electric Co, Cleveland, Ohio 44114
76684	National Tube Co, Pittsburg, Penn.
76854	Oak Mfg Co, Crystal Lake, Ill.
77147	Patton MacGuyer Co, Providence, R.I.
77166	Pass-Seymour, Syracuse, N.Y.
77263	Pierce Roberts Rubber Co, Trenton, N.J.
77339	Positive Lockwasher Co, Newark, N.J.
77542	Ray-O-Vac Co, Madison, Wisc.
77630	TRW, Electronic Comp, Camden, N.J. 08103
77638	General Instruments Corp, Brooklyn, N.Y.
78189	Shakeproof (Ill. Tool Works), Elgin, Ill. 60120
78277	Sigma Instruments Inc, S.Braintree, Mass.
78488	Stackpole Carbon Co, St. Marys, Penn.
78553	Tinnerman Products, Inc, Cleveland, Ohio
79089	RCA, Rec Tube & Semicond, Harrison, N.J.
79725	Wiremold Co, Hartford, Conn. 06110
79963	Zierick Mfg Co, New Rochelle, N.Y.
80030	Prestole Fastener, Toledo, Ohio
80048	Vickers Inc, St. Louis, Mo.
80131	Electronic Industries Assoc, Washington, D.C.
80183	Sprague Products Co, No. Adams, Mass.
80211	Motorola Inc, Franklin Park, Ill. 60131
80258	Standard Oil Co, Lafeyette, Ind.
80294	Bourns Inc, Riverside, Calif. 92506

Code	Manufacturer
80431	Air Filter Corp, Milwaukee, Wisc. 53218
80583	Hammarlund Co, Inc, New York, N.Y.
80740	Beckman Instruments, Inc, Fullerton, Calif.
81030	International Insturment, Orange, Conn.
81073	Grayhill Inc, LaGrange, Ill. 60525
81143	Isolantite Mfg Corp, Stirling, N.J. 07980
81349	Military Specifications
81350	Joint Army-Navy Specifications
81751	Columbus Electronics Corp, Yonkers, N.Y.
81831	Filtron Co, Flushing, L.I., N.Y. 11354
81840	Ledex Inc, Dayton, Ohio 45402
81860	Barry-Wright Corp, Watertown, Mass.
82219	Sylvania Elec Prod, Emporium, Penn.
82273	Indiana Pattern & Model Works, LaPort, Ind.
82389	Switchcraft Inc, Chicago, Ill. 60630
82647	Metals & Controls Inc, Attleboro, Mass.
82807	Milwaukee Resistor Co, Milwaukee, Wisc.
83033	Meissner Mfg, (Maguire Ind) Mt. Carmel, Ill.
83058	Carr Fastener Co, Cambridge, Mass.
83186	Victory Engineering, Springfield, N.J. 07081
83361	Bearing Specialty Co, San Francisco, Calif.
83587	Solar Electric Corp, Warren, Penn.
83740	Union Carbide Corp, New York, N.Y. 10017
83781	National Electronics Inc, Geneva, Ill.
84411	TRW Capacitor Div, Ogallala, Nebr.
84835	Lehigh Metal Prods, Cambridge, Mass. 02140
84971	TA Mfg Corp, Los Angeles, Calif.
86577	Precision Metal Prods, Stoneham, Mass. 02180
86684	RCA (Elect. Comp & Dev), Harrison, N.J.
86687	REC Corp, New Rochelle, N.Y. 10801
86800	Cont Electronics Corp, Brooklyn, N.Y. 11222
88140	Cutler-Hammer Inc, Lincoln, Ill.
88219	Gould Nat. Batteries Inc, Trenton, N.J.
88419	Cornell-Dubilier, Fuquay-Varina, N.C.
88627	K & G Mfg Co, New York, N.Y.
89482	Holtzer-Cabot Corp, Boston, Mass.
89665	United Transformer Co, Chicago, Ill.
90201	Mallory Capacitor Co, Indianapolis, Ind.
90750	Westinghouse Electric Corp, Boston, Mass.
90952	Hardware Products Co, Reading, Penn. 19602
91032	Continental Wire Corp, York, Penn. 17405
91146	ITT (Cannon Electric Inc), Salem, Mass.
91293	Johanson Mfg Co, Boonton, N.J. 07005
91506	Augat Inc, Attleboro, Mass. 02703
91598	Chandler Co, Wethersfield, Conn. 06109
91637	Dale Electronics Inc, Columbus, Nebr.
91662	Elco Corp, Willow Grove, Penn.
91719	General Instruments, Inc, Dallas, Texas
91929	Honeywell Inc, Freeport, Ill.
92519	Electra Insul Corp, Woodside, L.I., N.Y.
92678	E.G.&G., Boston, Mass.
93332	Sylvania Elect Prods, Inc, Woburn, Mass.
93916	Cramer Products Co, New York, N.Y. 10013
94144	Raytheon Co, Components Div, Quincy, Mass.
94154	Tung Sol Electric Inc, Newark, N.J.
95076	Garde Mfg Co, Cumberland, R.I.
95121	Quality Components Inc, St. Mary's, Penn.
95146	Alco Electronics Mfg Co, Lawrence, Mass.
95238	Continental Connector Corp, Woodside, N.Y.
95275	Vitramon, Inc, Bridgeport, Conn.
95354	Methode Mfg Co, Chicago, Ill.
95412	General Electric Co, Schenectady, N.Y.
95794	Anaconda Amer Brass Co, Torrington, Conn.
96095	Hi-Q Div. of Aerovox Corp, Orlean, N.Y.
96214	Texas Instruments Inc, Dallas, Texas 75209
96256	Thordarson-Meissner, Mt. Carmel, Ill.
96341	Microwave Associates Inc, Burlington, Mass.
96791	Amphenol Corp, Janesville, Wisc. 53545
96906	Military Standards
98291	Sealectro Corp, Mamaroneck, N.Y. 10544
98474	Compar Inc, Burlingame, Calif.
98821	North Hills Electronics Inc, Glen Cove, N.Y.
99180	Transitron Electronics Corp, Melrose, Mass.
99313	Varian, Palo Alto, Calif. 94303
99378	Atlee Corp, Winchester, Mass. 01890
99800	Delevan Electronics Corp, E. Aurora, N.Y.

9/68

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS 01781

617 369-4400 617 646-7400

SALES ENGINEERING OFFICES

NEW ENGLAND*
22 Baker Avenue
West Concord, Massachusetts 01781
Telephone 617 646-0550

METROPOLITAN NEW YORK*
Broad Avenue at Linden
Ridgefield, New Jersey 07657
Telephone N.Y. 212 964-2722
N.J. 201 943-3140

SYRACUSE
Pickard Building
East Molloy Road
Syracuse, New York 13211
Telephone 315 454-9323

PHILADELPHIA
Fort Washington Industrial Park
Fort Washington, Pennsylvania 19034
Telephone 215 646-8030

WASHINGTON* and BALTIMORE
11420 Rockville Pike
Rockville, Maryland 20852
Telephone 301 946-1600

ORLANDO
113 East Colonial Drive
Orlando, Florida 32801
Telephone 305 425-4671

* Repair services are available at these offices.

CHICAGO*
6605 West North Avenue
Oak Park, Illinois 60302
Telephone 312 848-9400

CLEVELAND
5579 Pearl Road
Cleveland, Ohio 44129
Telephone 216 886-0150

LOS ANGELES*
1000 North Seward Street
Los Angeles, California 90038
Telephone 213 469-6201

SAN FRANCISCO
626 San Antonio Road
Mountain View, California 94040
Telephone 415 948-8233

DALLAS*
2600 Stemmons Freeway, Suite 210
Dallas, Texas 75207
Telephone 214 637-2240

TORONTO*
99 Floral Parkway
Toronto 15, Ontario, Canada
Telephone 416 247-2171

MONTREAL
1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada
Telephone 514 737-3673

General Radio Company (Overseas), 8008 Zurich, Switzerland
General Radio Company (U.K.) Limited, Bourne End, Buckinghamshire, England
Representatives in Principal Overseas Countries

Printed in USA